

# COMMENTARIES ON ASA GRAY'S BOTANICAL TEXTBOOKS BY GRAY AND HIS CONTEMPORARIES (1836–1887)

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## ABSTRACT

Asa Gray (1810–1888) authored 11 different editions of his textbooks of botany during the second half of the nineteenth century. His books were considered by his contemporaries as models, the best ones written from the views of current botanical knowledge and for covering the entire scope of the subject as known in his day. This paper describes Gray's textbooks by using information from Gray himself as taken from (1) the books' prefaces and his correspondence with botanical friends, and from (2) commentaries from other writers in published reviews of his textbooks. Based on their titles, contents, and purposes, Gray's textbooks may be placed into three categories: those that (1) discuss the basic elements or provide the essential elements, written for beginning students in schools, published in 1836, 1857, and 1887; (2) have the word "textbook" in the title, written for students at the collegiate and secondary levels, published in six rewritten editions, 1842, 1845, 1850, 1853, 1858, and 1879; and (3) have a morphological-physiological orientation written for use in elementary schools, published in 1858 and 1872. Gray's textbooks were original contributions that organized botany into a more useful science and fulfilled the educational needs of the time. They were in demand for use in schools and the public in general, but after Gray's death, no one continued preparing revisions, and thus both their use and usefulness ceased.

## RESUMEN

Asa Gray (1810–1888) fue el autor de 11 ediciones diferentes de libros de texto de botánica durante la segunda mitad del siglo diecinueve. Fueron considerados por sus contemporáneos como modelos de libros bien escritos desde los puntos de vista del conocimiento botánico de su tiempo y de cubrir el espectro completo de materias conocidas en la época. Este artículo describe los libros de Gray mediante informaciones procedentes del mismo Gray tomadas de (1) los prólogos de los libros y de su correspondencia con amigos botánicos, y (2) de comentarios de otros autores en revisiones publicadas de sus libros. Basándonos en sus títulos, contenidos e intencionalidad, los libros de Gray pueden agruparse en tres categorías: (1) los que discuten elementos básicos u ofrecen estos elementos básicos, escritos para estudiantes principiantes en las escuelas, publicados en 1836, 1857, y 1887; (2) los que llevan la palabra "textbook" (libro de texto) en el título, escritos para estudiantes de segundo nivel y universitarios, publicados en seis ediciones revisadas, 1842, 1845, 1850, 1853, 1858, y 1879; y (3) los que tienen una orientación morfológica-fisiológica escritos para ser usados en escuelas elementales, publicados en 1858 y 1872. Los libros de



Gray fueron contribuciones originales que estructuraron la botánica en una ciencia más útil y satisficieron las necesidades educativas de la época. Tuvieron demanda para ser usados en escuelas y por el público en general, pero después de la muerte de Gray, nadie continuó haciendo las revisiones, y por ello cesaron tanto su uso como utilidad.

Asa Gray (1810–1888), considered the foremost nineteenth century botanist in the United States, authored 11 different editions of his textbooks of botany, regarded as among the best at that time in the United States. Published during the second half of the nineteenth century, Gray's books were considered by his contemporaries as models, because they covered the views of current botanical knowledge and the entire scope of the subject as known in his day. He wrote them at a level of comprehension and complexity different from most textbooks, in order that they would be available and useful to all ages and knowledge-levels of individuals wanting to have information about plants. Despite their widely recognized merit, no discussion, so far as is known, has ever been prepared on Gray's botanical textbooks. When one sees the various titles and dates of publication, either from a collection of the books in the library or in lists of textbooks, the complexity and confusion of this subject become apparent. Gray's biographer, A. Hunter Dupree (1959) offers very little information about Gray's textbooks, but his book has provided the chronological backdrop for the organization of this paper's text.

Because of the merit of Gray's textbooks, they are worthy of being identified and described. The procedure in this discussion follows the chronological order in which they were written and published.<sup>1</sup> Information about them is taken from two primary sources: (1) Gray himself, as the writer of the prefaces and correspondence with his botanical friends, and (2) commentaries in published reviews of his textbooks. Both of these sources contribute significantly and realistically toward an understanding of the content and quality of the books. The comments quoted from the reviews are the reviewers' opinions of Gray's books. Information on the content and quoted passages from the books, customarily used in the writing of book

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<sup>1</sup> The inspiration for writing this paper on Asa Gray's botanical textbooks came while reviewing abstracts and manuscripts of papers that Emanuel D. Rudolph (1927–1992) presented in 1971 and 1975 at two history of science meetings. This effort was part of the project of editing Rudolph's unpublished papers for their publication as a memorial volume (Stuckey and Burk, eds. In Press). A short paper of Rudolph's research on Gray's textbooks (Paper No. 3) appears in that volume. This paper is in part written from notes and quoted portions of Gray's letters published by Jane Loring Gray (1893) that Rudolph had collected, with the remainder based on research by Stuckey with generous bibliographic and word processing assistance from William R. Burk, Biology Librarian at the University of North Carolina, Chapel Hill. The first draft of this paper was written in December 1995 and revised with additions in December 1996, while at the University of North Carolina, Chapel Hill.



notices and reviews during the nineteenth century, are excluded from these commentaries. The reviews examined in this study were taken from the reference list compiled by Stuckey and Burk (1998, in press).

Based on their titles, contents, and purposes, Gray's textbooks may be placed into three categories: those that (1) discuss the basic elements or provide the essential lessons, written for beginning students in schools, published in 1836, 1857, and 1887; (2) are identified with the word "textbook" in the title, written for individuals in colleges and secondary schools, or for private students, published in six rewritten editions, 1842, 1845, 1850, 1853, 1858, 1879; (3) are the books which have a morphological-physiological orientation written for young people in elementary schools, published in 1858 and 1872. Gray's textbooks are described and discussed in chronological order of their writing and publication, rather than by the grouped topic. A list of their full citations at the time of their first publication is arranged in chronological order (Appendix I). Known reprint editions based on citations published in *The National Union Catalog, Pre-1956 Imprints* (Compilers 1972) are noted at the end of each citation of the corresponding original edition. Selected features of Gray's books not discussed in the text appear as an added summary (Table 1).

A true textbook is, according to the American Textbook Publishers Institute (1949, p. 19), a published work "especially prepared for the use of pupil and teacher in a school or class, presenting a course of study in a single subject, or closely related subjects." Textbooks, particularly those of wide use, according to Rudolph (1971, a, b), are by their nature repositories of generally accepted knowledge in any discipline at a particular period. The botanical textbook is here defined as a work that introduces students to current aspects of plant science, rather than a manual for the identification of particular plants. Textbooks are useful for the historian of science because they present in a concise way the generally held paradigms<sup>2</sup> of a period. Rudolph (1975) further noted: "They [textbooks] should provide an insight into the 'normal science' of the time. For textbooks are windows to the posture that the science takes when being presented to the initiate." The concept of "normal science" comes from Kuhn (1970), who defined it for the history of science.<sup>3</sup> The origins of textbooks are to be

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<sup>2</sup> "Paradigms," according to Kuhn (1970, p. viii) are "universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners."

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<sup>3</sup> "Normal science," according to Kuhn (1970, p. 10) is "research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice. Today such achievements are recounted, though seldom in their original form, by science text-



TABLE 1. Summary of Selected Features of Asa Gray's Botanical Textbooks

Abbreviated Title of Book	Year on Title Page	Year of Copyright	Copyright Owner	Date of Preface	Number of Illustrations <sup>1</sup>	Illustrator	Number of Additional Printings	Changes from Previous Edition
Group 1. <i>Elements and Lessons:</i>								
<i>Elements</i>	1836	1836	G. & C. Carvill & Co.	April 1836	125 <sup>a</sup>		none	————
<i>First Lessons</i>	1857	1857	George P. Putnam & Co.	1 January 1857	367 <sup>b</sup>	Isaac Sprague	17	————
<i>Elements</i>		1887	Asa Gray	March 1887	589 <sup>b</sup>	Isaac Sprague	3	"new and much revised"
Group 2. "True" <i>Textbooks:</i>								
<i>Textbook</i> ed. 1.	1842	1842	Wiley & Putnam	No Preface	78 <sup>a</sup>	Miss Agnes Mitchell;	none	————
<i>Textbook</i> ed. 2.	1845	1842	Wiley & Putnam	March 1845	1,045 <sup>b</sup>	Mr. J. J. Butler additional illustrations by Isaac Sprague	none	portions "entirely rewritten"
<i>Textbook</i> ed. 3.	1850	1850	George P. Putnam	April 1850	1,207 <sup>b</sup>	additional illustrations by Isaac Sprague	none	"rewritten and enlarged"
<i>Textbook</i> ed. 4.	1853	1853	George P. Putnam & Co.	March 1853	1,207 <sup>b</sup>	same as edition 3	none	"corrections and minor alterations"
<i>Textbook</i> ed. 5.	1858	1857	Iverson & Phinney	September 1857	1,336 <sup>b</sup>	Isaac Sprague	15	"almost entirely rewritten"
<i>Textbook</i> ed. 6.		1879	Asa Gray	10 April 1879	695 <sup>b</sup>		5	"entirely rewritten"
Group 3. "Botany for Young People:"								
<i>How Plants Grow</i>		1858	Iverson & Phinney	No Preface	519 <sup>b</sup>	Isaac Sprague	25	————
<i>How Plants Behave</i>		1872 1900	Asa Gray Jane L. Gray	2 February 1872	40 <sup>b</sup>	Isaac Sprague	4	————

<sup>1</sup>Figures are numbered by two methods:

<sup>a</sup>Each figure contains one or more individual illustrations, each designated with the letters a, b, c, etc. <sup>b</sup>Each individual illustration is given a figure number.



found in works such as Linnaeus' *Philosophia Botanica* (1751). The Linnaean model persisted throughout the eighteenth century and stressed gross structure and history as a tool for classification. This model, which was used in books in England and on the European Continent, was gradually replaced by works having greater emphases on plant function and geography. Asa Gray's botanical textbooks were examples of these latter works.

Of Gray's textbooks, Joseph C. Arthur (1895, p. 362) of Purdue University in his vice-presidential address of 29 August 1895 to Section G, Botany, of the American Association for the Advancement of Science spoke as follows:

Botany, as a substantial part of the curriculum, cannot be said to have received recognized standing in the American educational system until the time of Asa Gray. In the latter part of the decade of the thirties his first text-book, the 'Elements of Botany,' appeared, and in the decade following the 'Text-book for Colleges' and the 'Manual,' all of which works showed a true appreciation of the best features of the science and the needs of the time. They were so well conceived, and so much in demand, that new editions rapidly succeeded one another; and to the present day they hold a high place in the estimation of botanical teachers. These works possessed a specially potent element of virility in being the expression of knowledge at first hand, the words of the master. In so far as inspiration was drawn from foreign sources it came chiefly from French and English scholars, of whom De Candolle the eldest and Robert Brown were the representatives.

#### WRITING THE *ELEMENTS OF BOTANY* (1836)

By early 1835, the 24-year-old Asa Gray (Fig. 1), having graduated from medical school four years earlier, had concluded he did not want to practice medicine but become an authoritative botanist. Unemployed and living at home with his father in Sauquoit, New York, he "was requested to superintend the republication of some one of the most approved European treatises" (Gray 1836, p. x). As Gray began to work, he soon concluded that the European works were much too large, illustrated with expensive engravings, or contained a considerable quantity of information which did not belong in an elementary work. Gray decided "to engage in the more formidable task of preparing an original work, expressly adapted to the use of the student of North American Botany" (Gray 1836, p. x) He resolved to write an elementary textbook in botany. Gray needed money, but of equal importance was his desire to establish himself as a reputable botanist. A

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books, elementary and advanced. These textbooks expound the body of accepted theory, illustrate many or all of its successful applications, and compare these applications with exemplary observations and experiments."

"Normal science" and "paradigms" are similar in that both share in expounding the scientific achievement that is yet still open-ended to allow for various related problems to be studied or resolved by future research scientists, to whom Kuhn (1970, p. 10) refers to as the "redefined group of practitioners."





FIG. 1. Asa Gray (1810–1888), from a photograph in the Emanuel D. Rudolph collection, Archives, Herbarium, The Ohio State University, Columbus.

good textbook might initially earn \$300, but the project also might be of greater value to botanical science, for he believed that a new and original textbook should be made available. The book would be his own, like an American Lindley or a French de Candolle, arranged on the Natural System, rather than the antiquated, inferior Linnaean Sexual System as employed in the books written by Amos Eaton, and his student, Mrs. Almira Hart Lincoln Phelps. In this creative endeavor, Gray hoped to challenge



the European masters with a new standard of botanical excellence (Dupree 1959, p. 48).

Despite differences, distractions, and doubts, Gray forged ahead and wrote the manuscript during the summer and fall of 1835 and on into the winter of 1836. The book was to have a balance of information on form, function, and classification which allowed students to understand the entire science of Botany. His main concepts came from Augustin P. de Candolle of Geneva, Switzerland, the master of all fields of botany.

During the course of writing, Gray left home in the autumn of 1835 to reside in a boarding house in New York City, where he could be close to a scientific community and to publishers of textbooks. On 28 September he wrote his father: "As to my book, I am trying to make a bargain with two publishers; the prospects seem pretty fair, and I shall probably get \$300, which is the sum I insist on. I shall have a definite answer in a few days" (J.L. Gray, 1:54. 1893). Some years later while reflecting on those days, Gray noted: "[I] arranged with Carvill & Company to take my book. I think they gave one hundred and fifty dollars, which was a great sum for me" (J.L. Gray, 1:20. 1893).

To assist in proofreading and adding much to the clear, crisp, business-like prose, Gray (1880) had his 12-years older English friend John Carey, a gentleman of considerable botanical knowledge, revise the proof pages and help bring the manuscript to completion through the press. Gray signed the preface in April 1836, and 10 or 12 days later he expected the printed book. On 3 May 1836, Gray notified his friend Nathan W. Folwell, as quoted in Dupree (1959, p. 55), saying, "This preparatory training ... has prepared me most thoroughly for future progress, and if I happen to pursue Botany undividedly for a little time I shall (entre nous) be soon the best botanist in this country;" a strong boast for a young man who was soon to be age 25. Completion of Gray's first textbook came before his initial appointment to a university teaching position, his nonresident professorship appointment in 1838 at The University of Michigan (Bartlett 1941).

An original work, Gray's *Elements* was adapted to the student of North American Botany (Fig. 2). As Gray (1836, pp. x–xi) stated in the preface, its execution was not easy, chiefly because of the "difficulty of combining rigid perspicuity and philosophical accuracy with a popular form and a familiar style." To achieve this goal, Gray further wrote in the preface that he

freely made use of all the most approved works and original memoirs upon the subject that were within his reach, and has more particularly and constantly consulted the *Théorie Élémentaire, Organographie Végétale*, and *Physiologie Végétale* of De Candolle; the *Traité d'Anatomie Végétales*, and the more recent *Elémens de Physiologie Végétale et de Botanique* of Mirbel; the *Introduction to Botany*, the *Introduction to the Natural System of Botany*, and the *Ladies Botany* of Prof. Lindley; the Article *Botany*



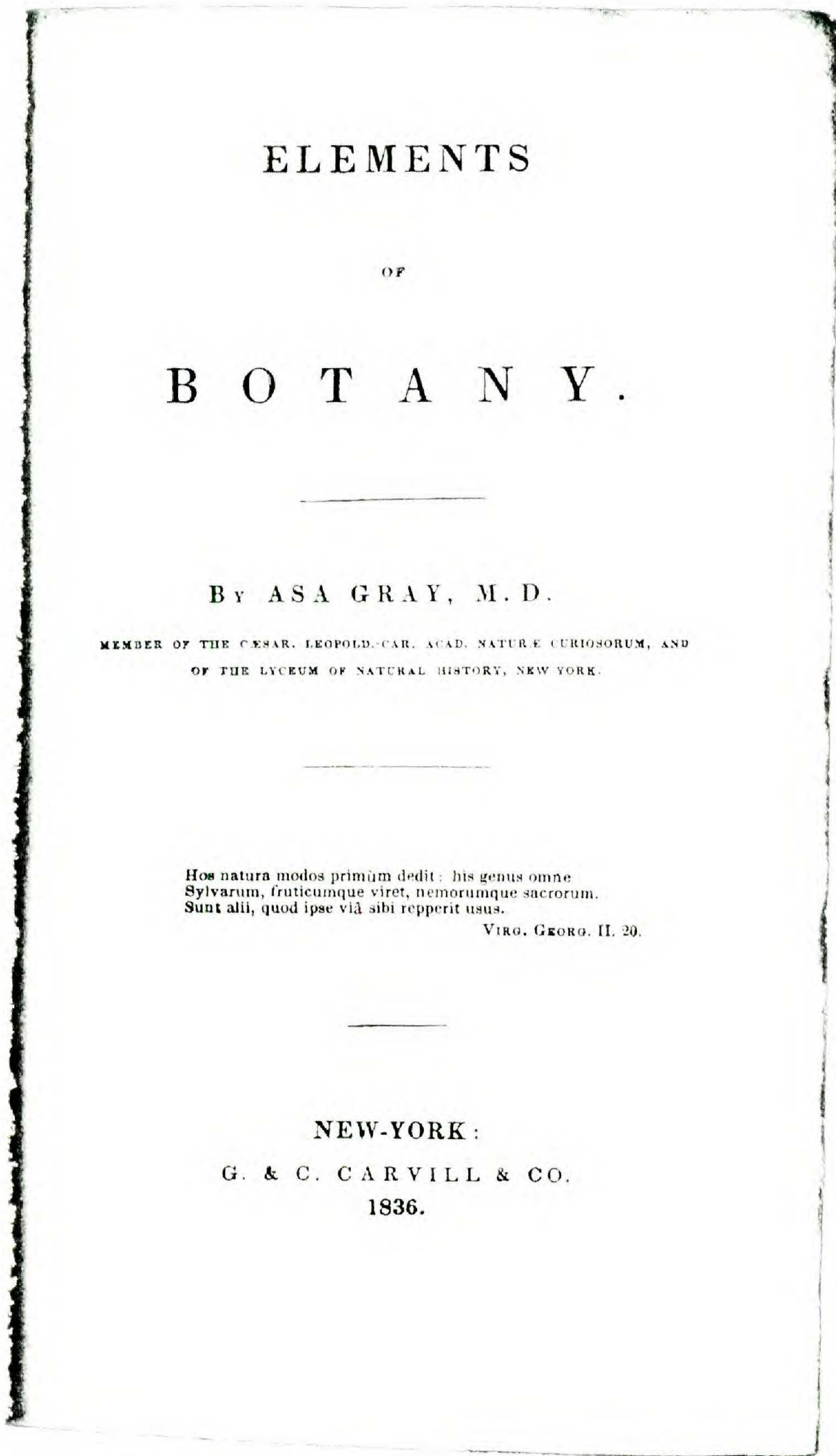


FIG. 2. Title page of Gray's *Elements of Botany* (1836).



in the seventh edition of the *Encyclopaedia Britannica*, by Mr. Arnott; and the fifth edition of the *Nouveaux Elémens de Botanique* of Achille Richard.

The *Elements*' (1836) preface outlined and described the contents, which basically contained three components: (1) Structural Botany, (2) Physiological Botany, and (3) Systematic Botany. The third component was further divided into (a) *Taxonomy*, the Principles of Classification, in which he favored the Natural System over the Artificial System of Linnaeus, (b) *Phytography*, an exposition of the Rules of Botanical Nomenclature with the idea of directing students' attention to this phase of botany whose importance had been undervalued and needlessly violated in this country, and (c) *Glossology*, the definition of the technical language used in describing plants, here confined to adjectival terms. An Appendix provided general directions for collecting and preserving plants for the herbarium, and contained a list of the plant families arranged in the Natural System.

Two reviews of Gray's *Elements* have been located. In the *American Journal of Science* (30:399. 1836), an anonymous writer, probably its editor Benjamin Silliman, wrote that Gray's book was "the best work on the philosophy of Botany that has appeared in this country, and ... that its merits will be appreciated by the numerous students of this science among us." The other review, signed "D," is believed to be Gray's friend, the physician William Darlington of West Chester, an authority on the flora of Chester County, Pennsylvania, who wrote in *The American Gardener's Magazine* (2:421–424. 1836):

... the aim of the author seems to have been to exhibit a full view of the present state of the science, with all the recent improvements and discoveries, condensed into a clear and perspicuous treatise, which, being sufficiently popular in expression, should at the same time retain that rigid accuracy so indispensably necessary to so extensive a branch of natural science. In this Dr. Gray has succeeded perfectly ... [by the] excellent arrangement of the subject, and the lucid manner in which the whole is illustrated and explained. Those persons who are not familiar with the large and expensive treatises published abroad, will find a great mass of new facts for study and digestion, and to those who are endeavoring to attain the elements of botany, we recommend this volume as a text book of the highest merit.

In later years, an anonymously written review in the *Bulletin of the Torrey Botanical Club* (6:317. 1879) referred to Gray's *Elements of Botany* (1836) as the book that provided this writer's "first insight into the science. We well recall the delight with which we read the clear elucidation of the subject—delight in the method, for we had no particular experience in the matter." Gray's British friend Joseph D. Hooker (*Nature* 37:376. 1888) noted:

The "Elements" is a noteworthy book; it was at once accepted as the best that had appeared in the States, and as second to none in the English language; its only rival was [the American edition of] Lindley's "*Introduction to the Natural System of Botany*," ... [which was used in] American schools.



PREPARING THE *BOTANICAL TEXT-BOOK* (1842)  
AND ITS REVISION (1845)

In 1841, Gray began to prepare a new textbook, even though he was in the midst of a commitment with John Torrey to write a *Flora of North America* (Torrey & Gray 1838–1844). Since botany was widely taught in the schools, he could at once obtain some needed cash, and because of Amos Eaton's death in 1842, Gray would be able to reach students previously served by Eaton and his followers. Gray could also nourish a new group of botanists capable of using, but who only incidentally were purchasing, his *Flora*. During the course of writing his textbook, Gray was offered and accepted on 30 April 1842, the appointment as the Fisher Professor of Natural History in Harvard University. With an added incentive of writing a good text for his forthcoming classes, and realizing the distinguished community he was about to join, he respectfully inscribed the book to the most eminent botanist of Boston, "Jacob Bigelow, M.D., F.L.S., Professor of Materia Medica in Harvard University; author of the *Flora Bostoniensis*, and of the *American Medical Botany*." He completed writing the textbook in late July, and arrived in Cambridge in sufficient time to take on his new position in September 1842. At Harvard the demands of science and the rewards from society came into balance for Gray, and the Fisher Professorship marked a real beginning there of a continuous scientific study of botany, as botany now was most important in Gray's life. Near the end of 1842, *The Botanical Text-book for Colleges, Schools, and Private Students* was published, having two parts, comprising "An Introduction to Structural and Physiological Botany," and the "Principles of Systematic Botany." On the title page was also the identification that Gray was Fisher Professor of Natural History in Harvard University. He noted that "it was in the course of printing when I was appointed to the Fisher professorship, so that I could put that title on the title-page, and have a text-book for my class" (J.L. Gray 1:28. 1893).

As was the situation earlier when writing the *Elements of Botany* (1836), Gray met with difficulties and delays in preparing *The Botanical Text-book* (Fig. 3). He wrote (J.L. Gray 1:282. 1893) to George Engelmann in St. Louis, 30 March 1842, saying:

Owing to illness I have as yet written almost nothing, and besides have to superintend all the drawings, as they must be made by a person unacquainted with botany; and at the same time I have to correct the proofs of about thirteen sheets yet of the "Flora," so that I am almost distracted when I think how I am to accomplish it here, where I have to see personally to almost every detail. But I must do it, as I hope to lay the foundation for a popular and—what is of consequence to me—a profitable work.



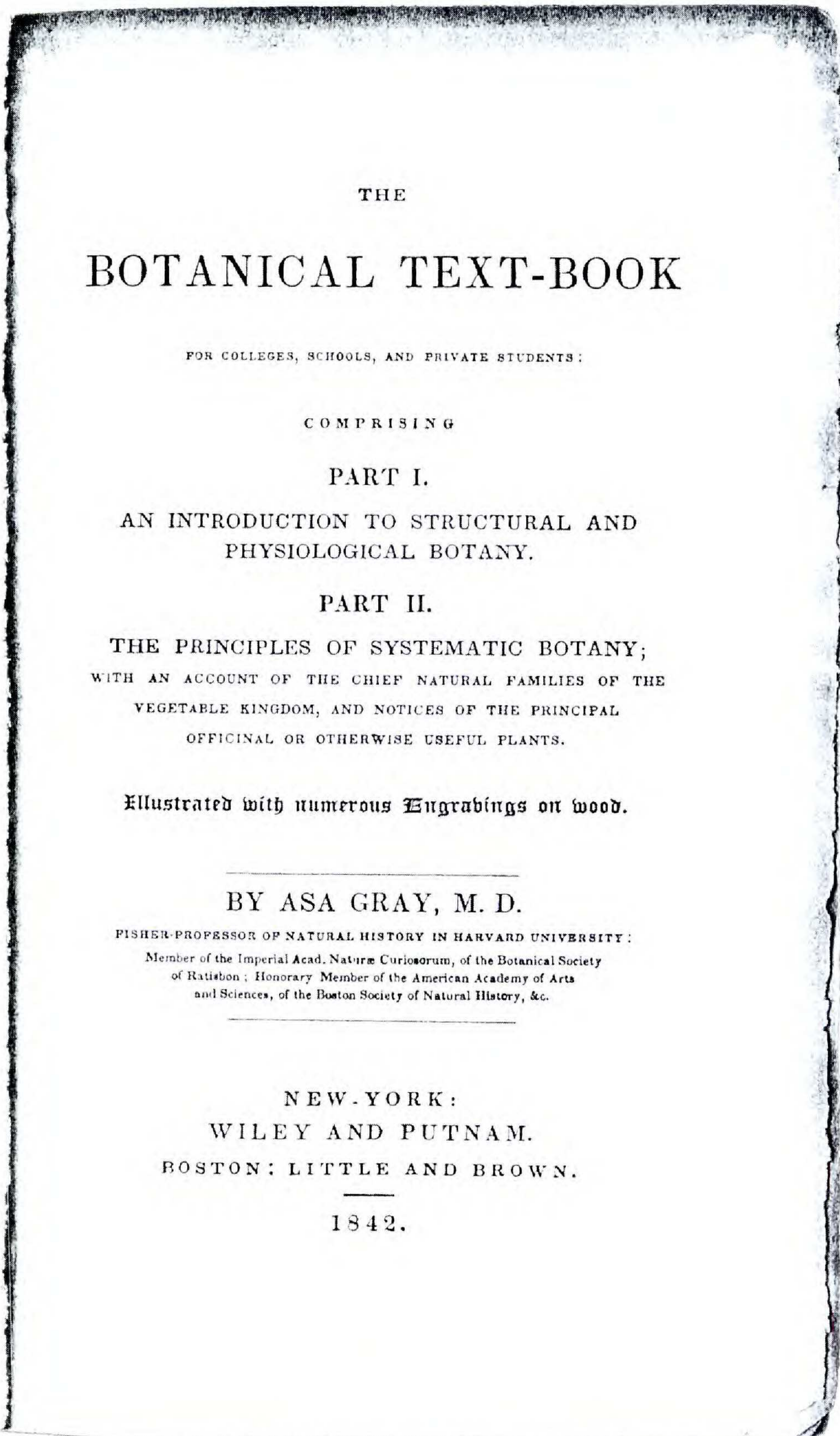


FIG. 3. Title page of Gray's *The Botanical Text-book* (1842).



No preface was written for this book, but Gray provided some comments about the first edition (1842) in the preface of the second edition (1845). Both students and botanists using the book gave favorable opinions which satisfied the author, even though the book was prepared in great haste and carried rapidly through the press. Gray agreed that the text arrangement was satisfactory, but he desired to prepare an even better book.

After the *Text-book* appeared, Gray enthusiastically wrote (J.L. Gray 1:297. 1893) to John Torrey, 3 January 1843, commenting on a review from a British journal:

The December number of [the] "Annals and Magazine of Natural History" [10:352-354. 1842] (of which Professor Balfour is the botanical editor) contains a very complimentary notice of the "Botanical Text-Book," accompanied with a few judicious selections, which shows that the writer has looked it over carefully; and winds up by terming it the best elementary treatise (as to structural botany) in the English language. So easy is it to get praise where it is not particularly deserved! ...

The major points of the review were:

It gives a comprehensive view of the present state of botanical science, and is written in a clear and lucid style, so as to render it accessible to all classes of readers. ... The work is illustrated with engravings on wood, which are highly useful to the student ... a good view is given of the principle of classification, and the Artificial and Natural methods are well explained ... The nomenclature of botany receives a due share of attention, ... Upon the whole, we look upon this work as one of the best Text-Books which ... has yet appeared.

Additionally, on the foreign scene, Gray's British friend William J. Hooker, in the *London Journal of Botany* (1:636. 1842) referred to Gray's second book as

... an immense mass of useful information, ... most perspicuously detailed, and rendered still more intelligible to the student, by the well executed figures, which are judiciously worked in with the type. We are much mistaken if this do[es] not become a popular book in our country.

A short review in *The Gardener's Magazine* (2, 3rd ser.: 634. 1842) conducted by J.C. Loudon of London stated that Gray's *Botanical-Textbook* "appears to us a very excellent work... [with] numerous woodcuts, which are very well executed; and the paper, type, and printing, are equal to those of any London publication."

The German botanist D.F.L. von Schlechtendal (*Botanische Zeitung* 1:50-51. 1843) made several comments, as noted in translation: (1) the printing and paper were superb making a positive impression, (2) the woodcuts were very clean, clear, and distinct, (3) the representative plants, taken from the North American flora, made the book especially interesting to European botanists, and (4) although concisely conceived and only intended for the beginner, Gray's text book touched upon everything interesting and worth knowing.



In the United States, two reviews are known: First, physician friend William Darlington (*American Journal of Science and Arts* 43:388–389. 1842) wrote:

The Text Book of Dr. Gray, affords at once the most compendious and satisfactory view of the vegetable kingdom which has yet been offered, in an elementary treatise, to the American public. In a style remarkable for its correctness and perspicuity, the author has traced and unfolded the vegetable structure, from its simplest forms up to its most complicated and elaborate developments. He has presented us with the first principles of the science, in accordance with the ... ["admirable doctrine of vegetable metamorphosis"] ... by which the external organs of plants are gradually modified, or metamorphosed, from the crude cotyledons of the germinating seed, to the most delicate component parts of the flower and the fruit. [Presentation of this doctrine] has, indeed, given to the science of botany an entirely new aspect.

Darlington also pointed out that with this textbook, "the teachers of botany ... may speedily elevate the study to its legitimate rank among the natural sciences... . [The student's] faculties of observation and comparison ... [will be] exercised according to the strictest rules of logic and philosophy." As Darlington further elaborated, the student can learn the true characters of the plants, to judge their economic value, and derive pleasure from studying the science itself. These advantages "may be confidently expected from the general introduction and proper use of the Botanical Text Book, ... "

Second, in the *North American Review* (56:192–207. 1843), George B. Emerson discussed and analyzed in detail various topics about plants in Gray's Textbook, including the movement of fluids in roots and stems, the theory of the transformation of leaves, the structure and symmetry doctrine of leaf arrangement, food and nutrition, and essential elements. The reviewer questioned Gray's introduction of the Natural System of plant classification in a basic textbook, when in reality the long-used Linnaean System of Classification had proven efficient and dependable for the beginning botanist in learning the organization of plants and their binomial names.

Reviewer Emerson, however, did recognize Gray's efforts to the extent that botany has become more than what Linnaeus had provided to his audience of that time period, stating that Gray's

... book puts within the reach of thousands the enlarged views and vast and exact knowledge of the Jussieus, of Linnaeus, of Richard, DeCandolle, and Robert Brown, men who deserve to be known to common fame, as among the greatest observers [of plants] and most original thinkers of the last hundred years.

Through his efforts of writing *The Botanical Text-book* (1842) Gray could serve science, and at the same time, also serve the general public. His second edition appeared in 1845, and Gray referred to this book in the preface (p. [9]) as a



... compendious treatise ... designed to furnish classes in our schools and colleges with a suitable text-book, as well as private students with a convenient introductory manual, adapted to the present condition of botanical science.

Believing that systematic botany is best studied when grounded upon structural and physiological botany, Gray wrote (1845) in the preface (p. 10) that these latter topics have been

... amplified to nearly twice ... [their] former extent, [and], ... have been almost entirely rewritten; ... the principal topics ... as far as is practicable in a brief and strictly elementary treatise ..., instead of having been rendered more abstruse by the enlargement, will rather be found to be more simple and generally intelligible than before. The chapters upon the Principles of Classification, and of the Natural System, have also been recast and somewhat enlarged.

An extensive, detailed account of this second edition appeared in the *North American Review* (61:254–258. 1845). The reviewer, George B. Emerson, stated that this new edition was necessary

... partly on the account of the rapid advancement which physiological botany ... is continually making; and partly because Dr. Gray's experience as a teacher ... has enabled him to discern ... the points which were defective, or which required more detailed explanation... . We are glad to see, therefore, that the author ... has made a good use of the opportunity, and of his professional experience, and has re-composed, and almost entirely rewritten, the first, and, in the author's view, the most essential, part of the work, that upon structural and physiological botany, ...

Among other changes were the doubling of the number of illustrative woodcuts and changes in style to render a more flowing narrative. The book was noted in the same review as being

... very neat and tasteful [in the] manner in which the mechanical part ... is finished. Its outside is as attractive as the subject of which it treats, the binding, print, paper, and engravings being not merely unexceptionable, but elegant. This is such a rare merit in a mere manual of instruction ... , a point of so much importance, that it deserves especial notice and commendation.

Later, in the July issue of the *North American Review* (67:180–182. 1848), John Carey, botanist who aided Gray with writing and proofreading his *Elements of Botany* (1836) concluded concerning Gray's 1845 edition, as well as Gray's previous elementary works, that they were

... entirely worthy of his well-established reputation. His subject is botany, but it is evident that he writes and feels as a general naturalist, and this is the point which we wish to have constantly kept in view. The details are minute and ample, and, for the most part, very concisely expressed; but he never loses sight of the great *generalizations* which must ever accompany progressive science. We think Dr. Gray has fairly realized his expressed design, "to furnish classes in our schools and colleges with a suitable text-book, ..."

D.F.L. von Schlechtendal (*Botanische Zeitung* 4:98–100. 1846), the German botanist, repeated that the examples from the North American flora serve



to recommend the work, but he was highly critical of the text on certain anatomical features, as indicated in translation:

... we find a substantial improvement in that the lesson on cells and vessels, as well as the sections that cover the main plant organs, are explained much more exactly with more consideration for all relationships and through more plentiful accompanying woodcuts. However, it seems to us that some sections are in need of elaboration, for example the one on cell contents, in which the green color should appear only in the places exposed to light and is derived from small grains. Moreover, no mention is made of either the starch nucleus of these grains or of the uniform green fluid; nor of any other colors, essential oils, or other substances that often fill entire cells. The trichome formations also are dealt with perfunctorily, and moreover no discussion is given about stellate trichomes, scales, or even of the waxy precipitates on the surface of the epidermis.

Certainly this significantly reworked edition will also find a better reception than the first, which makes this second edition necessary after only three years and at the same time serves as a witness to the ever expanding study of botany even in these regions, which, invigorated and made more common by his handbook, redounds to the author's joy and honor. Printing and paper are excellent.

THIRD EDITION OF THE *TEXTBOOK* (1850);  
COMPETITOR WITH WOOD'S *CLASS-BOOK* (1845)

About 1843 or 1844, Alphonso Wood, a teacher at an academy in Meriden, New Hampshire, who professed an interest in botany, came to talk with Gray on two occasions, proposing a joint-effort in writing a botanical textbook. Wood wanted to have a textbook for secondary schools which would also serve as a manual based on the Natural System of classification for the plants of the region. Like Amos Eaton, he thought practical plant collecting and identification, rather than structural-physiological botany was the proper approach for a beginning course, and hence Gray's *Botanical Text-book* (1842) was the primary target for replacement (Lyon 1939, p. 18; Willis 1881, pp. 54–55).

Wood's production was his *Class-book of Botany* (1845), and upon its appearance was destined to do more damage to the discipline of botany than threatening the income from Gray's text-book. Wood's book, according to Lyon (1939, p. 18), was fresh, complete, and original for its emphasis upon field work. It included the fundamentals of form and function of plants and was notable for its descriptions of plants in common language that was simple and accurate. The book was appropriate for Wood's "educational scheme of its time and aroused the interest of younger people in the plants," (Lyon 1939, p. 18). In the preface of the second and sometimes later editions of his *Class-Book*, Wood (1847, p. 3) stated that his book treated the basic elements of botany according to the latest authorities, and was written in the form of simple propositions, briefly illustrated, with



short paragraphs for the convenience of the learner. For students who aim toward a much higher level of botanical understanding, Wood wrote, "it affords us pleasure to be able to recommend ... the full and elaborate 'Text Book' of Dr. Asa Gray,—an American work of the highest merit." Gray did not have a glowing opinion of Wood's *Class-book* (1845). He noticed that it gave only scant coverage to anatomical and physiological botany and featured the flora of the northeastern portion of the United States, not as a mere list of families, as in Grays' *Text-book*, but with a brief English description of each species based on several sometimes unreliable sources. In Gray's mind, Wood's classification should not be allowed to become the standard guide for American plants. Gray immediately went to work to produce his own competing botanical *Manual* (1848) and followed soon after with a rewritten and enlarged third edition of his *Botanical Text-book* (1850), only five years from the issuance of the second edition (Gray 1845). The beginning of the preface (p. [v]) in this third edition is the same as in the second edition (1845), with "the structural and physiological part ... again almost entirely rewritten ... much enlarged ... the symmetry and morphology of the flower [has] ... been altogether recast and greatly extended." In a letter of 2 April 1850 to William J. Hooker (J.L. Gray 1:368. 1893), Gray noted:

The rewriting of all the structural parts of my 3d edition of the "Botanical Text-Book," which I was inadvertently drawn into, has proved a most time consuming business. It is not yet through the press.

By the time this third edition appeared, Gray had been to Europe a second time, primarily to study specimens of North American plants deposited in European herbaria. The only review seen of this third edition is by von Schlechtendal (*Botanische Zeitung* 9:157–158. 1851), who stated in translation:

The author has used the sources that he found in Europe, as far as they were accessible to him, but he has not incorporated all of the new views into his own, rather he followed in many points older views, namely those of A. P. de Candolle. This textbook will also enjoy a wide circulation.

#### EDITIONS FOUR AND FIVE OF THE *TEXT-BOOK* (1853, 1858)

New editions of the textbook, the fourth (1853) and the fifth (1858), the latter under the title *Introduction to Structural and Systematic Botany*, appeared during the next decade. The preface to the fourth edition (1853, p. vi) is the same as the one in the third (1850), but with the added notation:

The changes ... are comparatively small; consisting of corrections and minor alterations, especially in the parts which relate to Vegetable Anatomy and Physiology, and in the addition of a short Chapter on the Fecundation of Cryptogamous or Flowerless Plants.



The preface to the fifth edition (1858, p. [iii]) is similar to the one in the fourth edition (1853), but contains the following additional information:

... , the structural and physiological part of the work, and the chapters on the Principles of Classification and of the Natural System, have been again almost entirely rewritten, and such changes made as the advanced state of our knowledge required, or the author's continued experience in teaching has suggested. This has been done without increasing the extent of this part of the volume, which, considering the limited time devoted to the study in our colleges, &c., is found to be as full as is desirable for a text-book.

No reviews have been located for the fourth edition; a short review notice for the fifth edition (1858) appeared in the April number of the *North American Review* (86:587. 1858). The anonymous writer noted the immeasurable superiority of the natural system on a scientific basis, but that only a very brief skeleton-outline of the Linnaean system was provided in the book. The reviewer believed a more extensive account of the Linnaean system should have been included, because of an old love for that system. The Linnaean system was helpful in the identification of plants in flower by the novice in botany. Despite this exception, "Dr. Gray's Text-Book in its present form exists ... [as a] more perfect or satisfying manual for the student or the proficient [individual] in botanical science." Another writer, Isabella James, in the October number of the *North American Review* (87:326. 1858) compared this fifth edition with Gray's first edition of 1836, pointing out that this edition (1858) is twice the size, printed on better paper, entirely rewritten, and supplied with numerous illustrations, "from the hand of Mr. Isaac Sprague, who has received the well-merited title of the most accurate of living botanical artists." This writer also stated that Gray's Botanical Text-book gained consideration abroad and "that for some years it was used as the class-book in the University of Edinburgh—a compliment seldom paid to American works, ..."

Gray's textbook was essentially written for college students and presented the rapidly developing and changing ideas in botanical science. Consequently, a great void existed for younger students who needed a simpler work, and by the 1850s most secondary and elementary schools in the country were incorporating botanical study into their curriculum. By 1855 Alphonso Wood was industriously reaping profits with his *Class-Book*, now in its 41st printing (Lyon 1939, p. 82). What was Gray to do about this gap at the elementary level of the textbook series?

#### WRITING BOOKS FOR YOUNGER MINDS (1857, 1858)

Gray's publisher, G.P. Putnam and Company, had financial difficulties in 1854, and Gray shifted his books to Ivison and Phinney, New York, who were active textbook publishers. Under pressure from them, Gray wrote



his *First Lessons in Botany and Vegetable Physiology* (1857), designed for high school students (Fig. 4). It was reprinted over several years, with the title changed to *Gray's Lessons in Botany*, and later combined with his book *Field, Forest, and Garden Botany* (1868) to make a single volume called *Gray's School and Field Book of Botany* (1868) (Appendix II).

Gray believed that the basics of Botany was “one of the most generally interesting of the Natural Sciences, [and] surely ought to be taught, and to be taught correctly, as far as the instruction proceeds.” These words came from his *First Lessons* (1857, preface (p. [iii])). The book was

... intended for the use of beginners, and for classes in the common and higher schools, ... [The] Lessons are made as plain and simple as they well can be, ... have been carried far enough to make the book a genuine Grammar of Botany and Vegetable Physiology, and a sufficient introduction to those works in which the plants of a country—especially of our own—are described... . This work is complete in itself, as a school-book for younger classes, and even for the students of our higher seminaries... . [The book] comprises a pretty full account of the structure, organs, growth, and reproduction of plants, and of their important uses in the scheme of creation... . The book is also intended to serve as an introduction to the author's *Manual of the Botany of the Northern United States* ... and to be to it what a grammar and dictionary are to a classical author... . a full *Glossary, or Dictionary of Terms used in describing Plants*, is added to the volume.

Pennsylvania botanist Thomas C. Porter (*American Journal of Science and Arts* 73:439–440. 1857) wrote a most favorable review of Gray's *First Lessons* (1857):

Good elementary books in any branch of science are rare, ... Indeed, a good textbook of science, like a picture or a poem, is a work of art, the creation of which requires extensive knowledge, abundant resources and a generous and enthusiastic love of nature. And, even where these exist, none but a master can rightly seize the leading facts and principles and exhibit them in language at once precise, clear and simple—can be brief without being obscure and thorough without being prolix—can so fashion his teachings as to charm the youthful mind and lead it on imperceptibly into the very heart of the science—can furnish fresh and original illustrations of familiar objects in drawings and engravings, and give them that perfect accuracy which only an eye trained to a close scrutiny of forms can fully appreciate. Hence really excellent elementary books are rare indeed.

There is a special satisfaction, therefore, when these requisites are fulfilled, as is true in the case of the “First Lessons in Botany and Vegetable Physiology” from the pen of Dr. Gray. It is a model of its kind; and meeting a want long and widely felt, it must sooner or later win its way into all our schools and seminaries of learning... . Considering the intrinsic value of these books, the great care, labor and talent which have been devoted to their preparation, the good style in which they are published, and the great number and excellence of the their illustrations (from drawings by Mr. Sprague), the wonder is, that they can be sold at so moderate rates. We trust that they may meet with a circulation, proportioned to their real merit.

In England, an anonymous reviewer writing in the *Journal of Botany and Kew Garden Miscellany* (9:154–160. 1857) stated:



THE OHIO STATE UNIVERSITY  
HERBARIUM LIBRARY  
GIFT OF EMANUEL D. RUDOLPH

F I R S T

LESSONS IN BOTANY

AND

VEGETABLE PHYSIOLOGY,

ILLUSTRATED BY OVER 300 WOOD ENGRAVINGS, FROM ORIGINAL  
DRAWINGS, BY ISAAC SPRAGUE.

TO WHICH IS ADDED A COPIOUS

GLOSSARY,

OR

DICTIONARY OF BOTANICAL TERMS.

---

BY ASA GRAY,

FISHER PROFESSOR OF NATURAL HISTORY IN HARVARD UNIVERSITY.

---

NEW YORK:

IVISON & PHINNEY AND G. P. PUTNAM & CO.,

321 BROADWAY

CHICAGO: S. C. GRIGGS & CO., 111 LAKE STREET.

1857.

FIG. 4. Title page of Gray's *First Lessons in Botany* (1857).



Professor Gray has a thorough knowledge of his subject; he is a successful teacher, a lucid and accurate writer, and a most careful compiler and analyst ... The general character of his work ... [is] both scientific and simple, and as perfectly suited to its object as any work of the kind we have seen... . It is the first good indigenous American work on Elementary Botany, and it is written to meet an urgent want ... of a book adapted for the use of the classes in the common and higher schools of the United States; ... The illustrations are good ... of the subjects ... , and are said to be, almost without exception, original, ... [with] the skill and botanical accuracy of Mr. Sprague, who stands at the head of American botanical artists. We ... highly praise Mr. Sprague's exertions in making the illustrations, wherever possible, from American plants.

The reviewer made some critical remarks about the illustrations, the order of presentation for certain selected terms referring to the organs of plants, the failure to define a few words used, and the sketchy account of the procedures for collecting plants and making an herbarium.

D.F.L. von Schlechtendal (*Botanische Zeitung* 16:151. 1858), the German botanist, made several specific comments saying that the book:

(1) Explained everything as clearly and correctly as possible, (2) Offered a true grammar of botany and plant physiology, (3) Provided a satisfactory introduction to those books in which the plants of an area are described, (4) Drew examples from the North American flora, and (5) Would serve quite well for instruction, but for readers in Germany, the dose of anatomy and physiology should be richer.

Because Gray's textbooks were considered by many educators as too advanced for a large portion of the textbook market, Gray worked many evenings preparing a simpler book, *How Plants Grow* (1858), written for "young people and common schools," as stated on the title page (Fig. 5). It too, was reprinted for many years. These two elementary books differed from the advanced textbook only in being less complex, but not in content or mode of presentation. Gray's effort was to make real science easy and simple for the younger minds. Gray realized \$500 to \$600 per year from the sale of his textbooks during this period. Most of his intellectual pursuits during the 1850s were involved with the writing of these textbooks. Gray's attitude about producing them was stated in a communication (J.L. Gray 2:438. 1893) of 26 April 1856 to his British botanical friend George Bentham:

My last book [*How Plants Grow* (1858)] in elementary botany is now just off my hands, and will be out in a fortnight. I hope it will be of use. Forgive me for writing horn-books, and I am now done with that sort of work. There were several convincing reasons for doing it.

Gray's reasons for writing textbooks for the elementary student are further elaborated in a letter of 15 May 1857 to the Rev. R.W. Church, who was the rector of Whaley, a village in Scotland (J.L. Gray 2:429–430. 1893):

An acquaintance en route for Scotland has offered to take some small parcels for me. Among them is one I have taken the liberty to address to you, a copy of a very



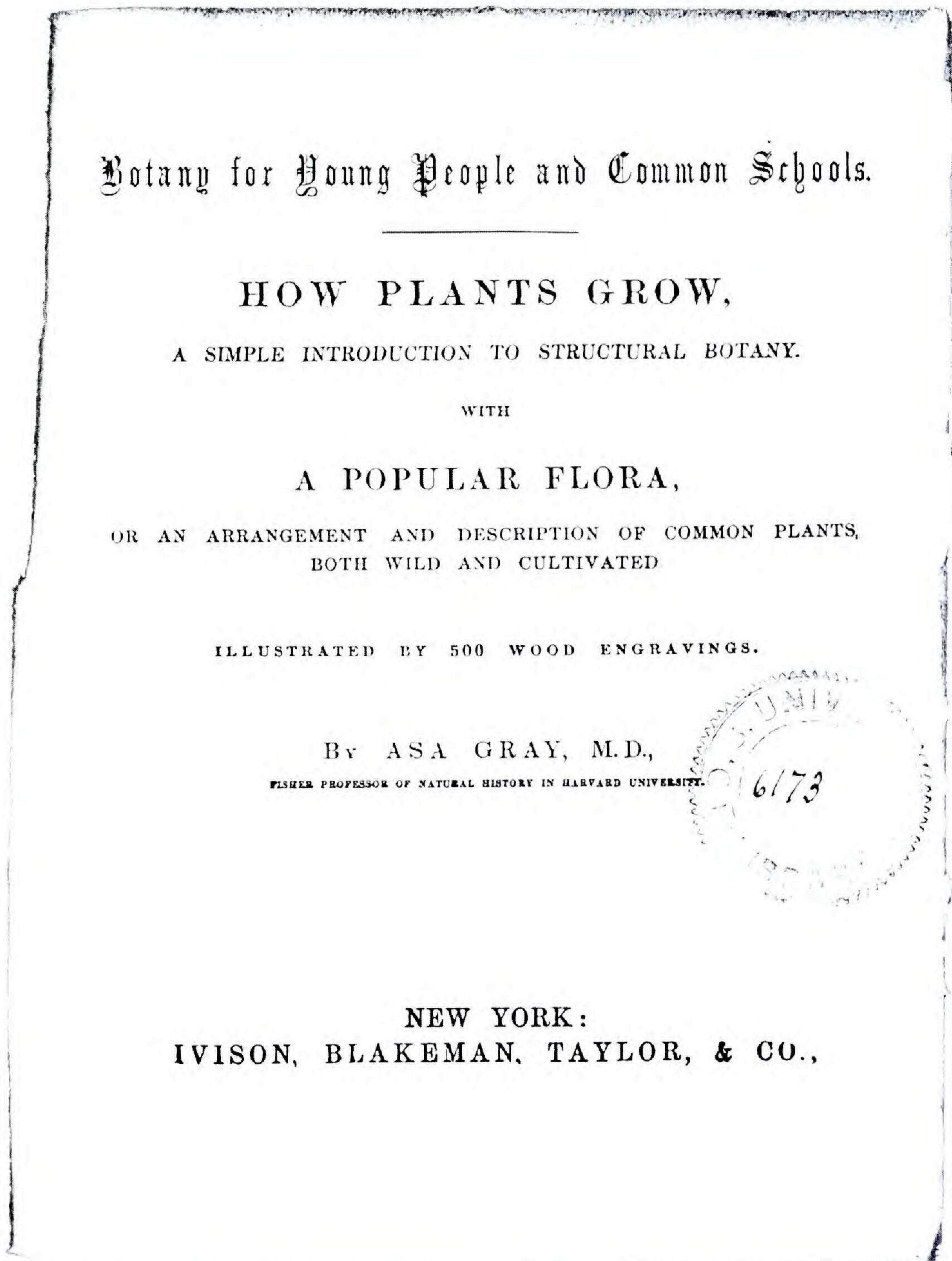


FIG. 5. Title page of Gray's *How Plants Grow* (1858).

elementary book [*First Lessons* (1857)] I have prepared as an introduction to my favorite science, finding there was no one in use here which I thought fit to put into the hands of young beginners. Here botany is taught, somehow or other, in most schools, and generally by incompetent teachers from wretched books, i.e., those used in the ordinary schools and for young people.

I have endeavored, in the little book I send you, to make real science as easy



and simple as possible. I doubt if I have yet aimed low enough; but the book seems to take, and promises to be useful.

As stated in Gray's introductory comments (p. 2) to *How Plants Grow* (1858), "this book is intended to teach Young People how to begin to read" about the vegetable kingdom. Conceived as the first of a two-part work on "Botany for Young People and Common Schools," this book has two major parts. The "First Part" considers how plants grow, and what their parts or organs are; how plants are propagated or multiplied in numbers; why plants grow; and how plants are classified, named, and studied. The "Second Part" consists of a popular flora for beginners for classifying and describing common wild and cultivated plants of the country. Following these parts is a dictionary of botanical terms used in this book.

Slightly over a year later on 1 June 1858, after *How Plants Grow* (1858) had been published, Gray sent the Rev. Church a copy of that book, with the following letter (J.L. Gray 2:444–445. 1893):

Last week the publishers at my request, sent ... a copy of a new and more elementary book [*How Plants Grow* (1858)] of mine than the one you are pleased to compliment. I intended that as a kind of horn-book, which Dr. Hooker insists it is not; and as something more simple was wanted here, to lead the way both to the "Lessons" and especially to the "Manual," which is rather strong for beginners, I have tried again, and you will see the result. I should have made the little "Popular Flora" fuller if the publishers had allowed more room. Having last year reëdited my "Botanical Textbook" ..., I have now done my part in elementary botanical writing, and I return with zest to my drier investigations ...

An anonymous reviewer (1858) in the *American Journal of Science* (76, 2nd ser., 26:139–140. 1858) wrote concerning *How Plants Grow* (1858):

The work is simple in style, and beautiful in its illustrations. While teaching with clearness the details of the subject, it is constantly bearing the mind, by simple explanations, above these details to higher thoughts and principles, and preparing it for the fuller survey of the science in the more extended works of the author's series... . The excellence of the volume consists in its being really "science made easy"—not by culling out "interesting facts" to attract, and tying them artfully together, but by presenting the *system of fundamental truths* in a manner intelligible and attractive to the young mind.

In the October number of *North American Review* (87:322–326. 1858), Isabella James stated with reference to Gray's two books for young people, *The First Lessons* (1857) and the *How Plants Grow* (1858):

The excellence of these elementary books is what every one who has had any knowledge of Dr. Gray's previous works must have expected; for to a perfect knowledge of his subject he adds a clearness and exactness of style seldom met with, and the power of condensing in a few words a great amount of information. As an accurate analyst, he has received a just meed of praise from all foreign botanists. Standing as he does at the head of the science in our own country, and scarcely inferior to



any botanist of the Old World, we consider it a subject of congratulations that he has found time, among his multifarious avocations of a high order, to write two books expressly for the young. The urgent need of a botanical primer, to introduce so charming a study into the school-room in a form attractive to children, has long been felt. The habits of observation, research, memory, and judgment ... are the very qualities which are most needed in every day's practical life; and if by proper educational training these discriminating powers are quickened at an early age, they will continue a constant and unfailing source of instruction and delight.

[*How Plants Grow* (1858)] ... may be truly called a wonderful book. The style is thoroughly scientific, and yet so clear and simple that even a little child can understand it, and become interested in the subject. It is not, like some popular works, written so far down to the comprehension of the young as to become a weak mixture, where science is diluted to the lowest possible standard, as if to keep the young mind for ever in swaddling-bands; but it is arranged and designed so to educate and expand the intellect as that a young person of ordinary capacity is soon able to seize upon, and comprehend, the principal features of the vegetable world.

When a work like this, combining in so rare a manner the two sterling qualities of excellence and cheapness, adapted expressly to young persons, and arranged for the use of schools, emanates from the highest botanical authority, we trust a discriminating public will show a just appreciation of its merits, by discarding all the trashy volumes now in use, and adopting one which comprises in a small space the learning and research of a life devoted to the subject.

Botanical historian Frederick Brendel (1879, p. 754) wrote, "For until Prof. A. Gray's popular book, 'How Plants Grow' appeared in 1858, not a single work of any importance [for young people] was published in this country." In France, in the *Bulletin de la Société Botanique* (15:655–656, 1858), an anonymous writer noted that "L'exécution typographique en est fort remarquable," for the 500 figures drawn by Isaac Sprague, the most accurate botanical illustrator of that time (Rudolph 1990).

FOUR-PARTS PROJECTED FOR THE *TEXT-BOOK'S*  
SIXTH EDITION (1879, 1885)

Twenty years passed before Gray returned in the late 1870s to the task of revising the fifth edition of his *Text-book* (1858). In 1872, Gray contemplated doing the revision, but time proving insufficient, he asked George L. Goodale, his new colleague, to help in its preparation. Goodale came to Harvard University in the fall of 1872 to assume some of the regular classes taught by Gray. During the following year Gray retired from classroom teaching, and Goodale received the appointment as Fisher Professor of Natural History. Much new information had become available in the now-expanding and more widely developing botanical discipline since the fifth edition was published, and Gray conceived that the new version would need to be expanded into several parts.

A four-volume effort was envisioned, and the first volume on *Structural*



*Botany* (1879), concerning the morphology, taxonomy, and phytography of phanerogams was, compared to previous editions, entirely rewritten by Gray. According to the preface (p. [iii]):

The present treatise is intended to serve as a text-book for the higher and completer instruction. To secure the ... whole range of subjects, it has been decided to divide the work into distinct volumes, each a treatise by itself, which may be independently used, while the whole will compose a comprehensive botanical course. This volume, on the Structural and Morphological Botany on Phaenogamous Plants, properly comes first. It should thoroughly equip a botanist for the scientific prosecution of Systematic Botany, and furnish needful preparation to those who proceed to the study of Vegetable Physiology and Anatomy, and to the wide and varied department of Cryptogamic Botany.

After the book was available, Gray mailed one to George Engelmann, 22 May 1879 (J.L. Gray 2:687. 1893), noting: "I send you by mail a copy of my new 'Text-Book.' You see I relegate to other hands the anatomy, physiology, and cryptogamia,—glad to be rid of them." Indeed, not all of the usual botanical information was included in the first volume of the new sixth edition.

In the extensive review of the Sixth Edition, Gray's colleague George L. Goodale (*American Journal of Science and Arts* 118:73–76. 1879), reminded the reader that in Gray's first book, *The Elements of Botany* (1836):

The plan of this early work was generous in its scope, and was philosophically developed. A morphological basis was adopted as the only safe one on which to build, and upon this a symmetrical superstructure was erected. It was no ordinary sagacity which led a young botanist, without experience in teaching, to select a method which has needed no essential change for forty years, and which is to-day generally accepted as best adapted to elementary and advanced instruction. The "Text-book," which was developed from the earlier "Elements of Botany," has passed through several editions ... A still further development of the plan ... necessitated a division into separate volumes, ... [of which this volume is the first of four volumes planned]... . The present volume ... is adapted ... to the wants of the advanced student and the working botanist alike.

An anonymous author in the *Bulletin of the Torrey Botanical Club* (6:317–320; 328–329. 1879) wrote that Gray's Part I of the Sixth Edition (1879)

... will undoubtedly for years to come be the main text book on the science in our colleges and scientific schools, containing as it does the latest results in this department, treated with a mastery and a clearness of which we know no equal.

Henry Trimen, the editor of *The Journal of Botany British and Foreign* new ser. (8:253–254. 1879), published at the British Museum in London also reviewed Gray's sixth edition, Part I (1879). After noting that the book "is strictly devoted to the morphological anatomy of Phanerogams with sections on the principles regulating their classification, description, and nomenclature," Trimen wrote:



It was, indeed, the masterly and philosophical treatment of these sections of the science which always gave to the *Text-Book* its special value; they have been particularly the branches to which the author's long and laborious life has been devoted, and it is with great satisfaction that botanists will receive this fuller treatment of them at his hands.

The whole has been entirely re-written, and it is scarcely necessary to say, well written. Dr. Gray is able to convey strictly technical instruction in the attractive and easy style only reached by a few masters.

Charles E. Bessey, one of Gray's former students who became a distinguished teacher of botany, wrote in the *American Naturalist* (14:870. 1880), that Gray's Sixth Edition (1879) ranked "as one of the best books on structural botany extant." An anonymous reviewer in the *Bulletin de la Société Botanique de France* (26:165. 1879) commented on its successful perfection, as were each of the previous editions.

Later, George L. Goodale published the second volume on *Physiological Botany* (1885), but the two remaining planned volumes were never published. Gray's other colleague William G. Farlow was to write the third volume on an *Introduction to Cryptogamic Botany, both Structural and Systematic*, and Gray the fourth volume on a *Sketch of the Natural Orders of Phanerogamous Plants, Including Their Special Morphology, Classification, Distribution, and Products*. Farlow (1890) wrote: "It is deeply to be regretted that he [Gray] was never able to write this volume, for it would have enabled him to present the general views on classification derived from a long and exceptionally rich experience." He did not comment on why his own volume number three also was not written.

An anonymous reviewer of Goodale's *Physiological Botany* (1885) in the *Botanical Gazette* (10:392–393. 1885) wrote:

... here is a really new book; not new in its facts, of course, but essentially new in the arrangement, and thoroughly original in the presentation of them ... [A] very wide range of literature from which these facts have been gathered ... [and] copious references to the literature, and in many cases a citation of the passage in point ... The reader will also be impressed with the comprehensiveness of the treatment.

J.C. Arthur (1895, pp. 369–370) spoke of Goodale's Part II as a work covering a broad scope, including histology, anatomy, and ecology, as well as physiology proper. Of the last item, he recognized it as

... by no means the most conspicuous part of the book. The encyclopedic ful[l]ness of the work better adapted it for a reference-book to accompany a course of lectures than as a textbook. It greatly helped the science in America however, especially as it stimulated experimental study by a set of laboratory exercises given as an appendix... [Goodale's book] appeared ... first, and to the present [is] the only treatise on physiological botany by an American author.



## MORE BOOKS FOR ELEMENTARY STUDENTS (1872, 1887)

Gray's earlier book *How Plants Grow* (1858), was as stated on the title page, a simple introduction to structural botany with a popular flora illustrated with 500 wood engravings. Furthermore, the title page identified the book as "Botany for Young People and Common Schools." Having years earlier written to the Rev. R. W. Church of Scotland that he had finished his writing of textbooks for children, the urge; however, must have returned. Gray now wrote a companion book to *How Plants Grow*, calling it *How Plants Behave* (1872), which as stated in his preface (pp. [vii–viii]) was a topic to which he "long wished to introduce pupils of an early age." He described that topic as being

... admirably adapted, while exciting a lively curiosity, to stimulate both observation and thought, ... Not only [should young people ask about] 'How Plants Grow,' but [also] 'How Plants Act.' [The plant phenomena] in certain important respects [are] easy to be observed,—everywhere open to observation, but (like other common things and common doings) are very seldom seen or attended to. [It adds] some very interesting chapters to the popular history of Plant-life... written with a view to elementary instruction ... with all practicable plainness, the subjects here presented are likely to be as novel, and perhaps as interesting to older as to younger readers.

[Gray hoped that] this little treatise, designed to open the way for the young student into this new, and, I trust, attractive field, may be regarded as a supplement to the now well-known book, [*How Plants Grow*].

Gray discussed three major topics in *How Plants Behave* (1872): (1) The motions of plants including climbing, (2) plants that are carnivorous, and (3) the fertilization of plants by insects. These themes are discussed in "the simplest and [yet] most comprehensive statement" made by the author, as noted by the Rev. C. E. Bolles in the *American Naturalist* (6:475–477, 1872). This reviewer stated further that Dr. Gray

... appears to recognize a personality in plants—at least he is careful, all the way through, to show that the actions which he explains are the result of the plant's will; and just as far as botanical science allows, he assigns the reasons for them.

An anonymous reviewer in the *Bulletin of the Torrey Botanical Club* (3:35, 1872), noted:

The book is attractive in form, and we hope [it] may lure the young to our favorite study. To more mature minds, imbued with a love of Nature, it cannot fail to prove of great interest.

Following Gray's death in 1888, Joseph D. Hooker (1888) in his account of Gray's life wrote that these two smaller books "for charm of matter and style, have no equal in botanical literature ..."

In 1887, just before departing on his last European journey, Gray finished



a small book, *The Elements of Botany* ... (1887) containing in an abbreviated format the substance of the earlier *Structural Botany Textbook* (1879), as well as some chapters on cryptogams. He chose the same title for this book as he had for his earliest book in 1836, but since those copies were long out-of-print and rarely seen, he saw no inconvenience by reusing the former title. The book was identified on the title page as being "for beginners and for schools." It also replaced his *Lessons in Botany and Vegetable Physiology* (1857), published 30 years previously. As stated in the *Elements'* preface (pp. [iii]–iv), the book was for beginners learning structural botany and the principles of plant life, mostly as they pertained to flowering plants, "with which botanical instruction should always begin" to quote Gray. The book was also to be a companion and interpreter for his Manuals and Floras.

... this treatise should teach that the study of botany is not the learning of names and terms, but the acquisition of knowledge and ideas... . the Glossary ... has been considerably enlarged. It ... include[s] not merely the common terms of botanical description but also many which are unusual or obsolete.

George L. Goodale, in his review in the *American Journal of Science and Arts* (134:495. 1887), described Gray's *Elements* (1887), as a new work differing

... in many features from any of its predecessors. It embodies the grammar of Organography, the first principles of Vegetable Physiology, and of Botanical classification, and gives with the help of an adequate glossary, directions for the description of plants. The bringing so much within so narrow a compass has been accomplished by giving the kernel of every topic with out any husks ... It is ... adapted to the wants of classes and of those who are obliged to study by themselves.

Charles E. Bessey, recognized as a master of the botany teaching profession, wrote a review in the *American Naturalist* (22:46–47. 1888), comparing in numerous details Gray's first *Elements* (1836) and this *Elements* (1887). For example, in the first book, 18 pages were written on the Linnaean Sexual System, and 44 pages were devoted to the Natural System, which was necessary to justify its inclusion. In this book

... a short paragraph is all that remains of the discussion of the Linnaean System, and less than two pages suffice for the Natural System... . Not only do these contrasts show us what advances have been made in botany in half a century, but a comparison of these two books shows, still more, the remarkable growth and perennial youth of the master-mind who wrote them. It is not given to many men to live to see such great changes in the aspect of science as has been the good fortune of Dr. Gray, and still fewer have had the strength or ability to adapt themselves to the new views and theories.

Walter Deane (1888, p. 65), Gray's friend and obituary author, noted that these "two books are a most fitting Alpha and Omega to his industrious life. [Of the latter], he always spoke with much enthusiasm in regard to this revised work and seemed much pleased with the result."



In the *Botanical Gazette* (13:41. 1888), an anonymous reviewer stated, concerning Gray's *Elements* (1887):

No text-book has been more widely used than the one of which this is a revision; and nothing could be more appropriate than for the author himself to give a final revision, which has been long demanded by our rapid advance in knowledge. There can be no doubt that this is the best book for its purpose that we now have.

This writer pointed out errors in the use of anatomical terminology and the choice of poorly illustrated "old figures," but concluded with a final statement:

Although more concession to the results of modern botanical work might have been expected, the author may have been wisely conservative, and his justly great name insures a book that can be trusted.

British botanist James Britten, writing in the *Journal of Botany British and Foreign* (26:92–93. 1888), provided a review of Gray's *Elements* (1887):

This new edition of an old favourite ... [is] the last which will come from the hand of the venerable and kindly writer... . Dr. Gray's work, throughout his long and active botanical career, has been marked by clearness and consistent usefulness; and these characteristics are as noticeable in a work like the present as in the greater undertakings by which his position among botanists has been secured.

#### FURTHER CONTEMPORARY COMMENTS OF EVALUATION

Charles Bessey (1888, p. 280) considered Asa Gray "a great man." As a New York village school boy, Gray was "so far removed from all incentives to the study of science, [nevertheless he became] the future leader of one of the great branches of science in America."

With Gray's death on 30 January 1888, the pen of nineteenth century America's greatest botanical textbook writer was laid to rest. Joseph D. Hooker (1888) wrote after Gray's death:

... [the *Elements of Botany* (1836)] ... was the first of a series of editions of a work that has been for nearly half a century the text-book of schools and colleges throughout the United States, and the latter issues of which have been generally recommended by the botanical professors of the United Kingdom as the best of its class.

Gray's colleague in cryptogamic botany at Harvard University, William G. Farlow (1890, pp. 772–773), summed Gray's contributions to the writing of botanical textbooks as follows:

No better text-book on the subject had ever been written in the English language than Gray's "Text-Book" in the original form; and, although botanical instruction is now very different from what it used to be, it is still true that, as an introduction to the study of Phaenograms [i.e. Phanerogams], the group to which beginners naturally turn their attention, the later "Structural Botany," is likely to hold its own for some time to come.

Dr. Gray had the rare faculty of being able to adapt himself to all classes of readers. With the scientific he was learned, to the student he was instructive and suggestive, and he charmed the general reader by the graceful beauty of his style,



while to the children he was simplicity itself. The little books, "How Plants Grow," and "How Plants Behave," found their way where botany as botany could not have gained an entrance, and they set in motion a current which moved in the general direction of a higher science with a force which can hardly be estimated. His scientific friends, especially those abroad, sometimes blamed him for spending time in popular writing; but he may have understood himself and his surroundings better than they. With him botany was a pleasure as well as a business. Few wrote as easily as he, and, so long as he spent most of his time in higher work, he certainly had a right to amuse himself with writings of a popular character if he chose. As it was, he interested a multitude of readers in the subjects which he had at heart . . . .

Later, Farlow (1895, pp. 173, 174–175) further wrote:

The numerous editions of Gray's *Text-Book* made his name known in all the higher schools in the country, . . . He left a great nation in which, very largely through his exertions, the value of botany had become generally recognized and in which a crowd of young workers had arisen anxious to carry out the good work . . . .

#### SUMMATION

Asa Gray's recognition as the foremost nineteenth-century botanist of North America was earned not only because of his creative research and investigations on the flora of that continent, but also as an author of seven editions of his *Manual of the Botany of the Northern United States* (1848–1908). These books described the species and provided keys for their identification. Gray also may be recognized with this distinguished title because of his authorship of 11 different editions of textbooks of botany. In these books Gray developed botany into a more precise science, as he drew from the great Swedish botanist, Carolus Linnaeus, the French botanists A. P. de Candolle, A. L. de Jussieu, C. F. Mirbel, and Achille Richard, and the Englishmen Robert Brown and John Lindley. He ignored or chose not to extract from the German writers, who were well advanced in experimental laboratory approaches in the teaching and researching of botany. These approaches had not yet been inaugurated in the schools teaching botany in the United States except for the early efforts of Charles E. Bessey.

Gray's textbooks were original and fulfilled the needs of the time. They were in demand as both the purchasing population and the scientific information about the plants expanded. New editions with broader dimensions for different audiences became a necessity, and consequently previous editions were revised, rewritten, or expanded. After 1858, his books underwent many printings. As an example of the usefulness and demand for Gray's textbooks, Stuart G. Noble in his *A History of American Education* (1954) wrote that Gray's *How Plants Grow* (1858) was continued in use until 1900. From 1896 to 1900 it was

used in more schools than any other text. . . . the chief emphasis of the text was upon anatomical structure and classification. Numerous technical terms were used and



the logical treatment was maintained. Under this leadership instruction in botany became formal and highly technical.

After Gray's death, no one continued preparing revisions of his textbooks, and thus both their use and usefulness ceased. At the end of the nineteenth century, the German modeled botanical teaching laboratory was developed in the United States (Rudolph 1996). New textbooks were designed for these new teaching situations.

#### ACKNOWLEDGMENTS

Special thanks go to: (1) William R. Burk, Biology Librarian, University of North Carolina at Chapel Hill, who located most of the book reviews and read, edited, and word processed the manuscript; (2) Judith A. Warnement, Librarian, Harvard University Botany Libraries, Cambridge, who provided some of the book reviews and photocopies of prefatory pages of several textbooks; (3) Jimmy Dickerson, Chemistry Librarian, University of North Carolina at Chapel Hill, who translated the reviews of D.F.L. von Schlechtendal into English. Most of Gray's textbooks discussed in this paper are in the Emanuel D. Rudolph collection in the Herbarium Library at The Ohio State University. Some of the reviews and textbooks were obtained for examination from the Marston Science Library at the University of Florida, Gainesville.

#### APPENDIX I

### A CHRONOLOGICALLY ARRANGED LIST OF ASA GRAY'S TEXTBOOKS OF BOTANY

1836. *Elements of Botany*. G. & C. Carvill & Co., New-York. xiv, 428 pp.
1842. *The Botanical Text-book for Colleges, Schools, and Private Students: Comprising Part I. An Introduction to Structural and Physiological Botany. Part II. The Principles of Systematic Botany; With an Account of the Chief Natural Families of the Vegetable Kingdom, and Notices of the Principal Officinal or Otherwise Useful Plants*. Illustrated with numerous engravings on wood. Wiley and Putnam, New-York; Little and Brown, Boston. xii, [13]–413 pp.
1845. *The Botanical Text-book, for Colleges, Schools, and Private Students: Comprising Part I. An Introduction to Structural and Physiological Botany. Part II. The Principles of Systematic Botany; With an Account of the Chief Natural Families of the Vegetable Kingdom, and Notices of the Principal Useful Plants*. 2nd ed. Illustrated with more than a thousand engravings on wood. Wiley and Putnam, New-York. [1–9], 10–509 pp.
1850. *The Botanical Text-book, an Introduction to Scientific Botany, Both Structural and Systematic. For Colleges, Schools, and Private Students*. 3rd ed., rewritten and enlarged. Illustrated with twelve hundred engravings on wood. George P. Putnam, New York. xii, [13]–520 pp.
1853. *The Botanical Text-book, An Introduction to Scientific Botany, Both Structural and Systematic. For Colleges, Schools, and Private Students*. 4th ed. Illustrated with twelve hundred engravings on wood. George P. Putnam & Co., New York. xii, [13]–528 pp.
1857. *First Lessons in Botany and Vegetable Physiology*, Illustrated by over 360 woodcuts, from original drawings, by Isaac Sprague. To which is added a copious glossary, or dictionary of botanical terms. Ivison & Phinney and G. P. Putnam & Co., New York; S. C. Griggs & Co., Chicago. xii, 236 pp. [Reprinted as Gray's *Lessons in Botany* beginning in 1868; Reprints listed in *The National Union Catalog* (1972):1859, 1860, 1862, 1863, 1864, 1865, 1866, 1867, 1868, 1869, 1870, 1872, 1873, 1874, 1875; Reprint also listed in *WorldCat* (OCLC First Search):1858, 1886].



1858. Introduction to Structural and Systematic Botany, and Vegetable Physiology, Being a Fifth and Revised Edition of The Botanical Text-book. Illustrated with over thirteen hundred woodcuts. 5th ed. Ivison and Phinney, New York; S. C. Griggs & Co., Chicago. xii, [13]–555 pp. [Title page 1858, copyright 1857; Reprints listed in *The National Union Catalog* (1972): 1860, 1862, 1864, 1865, 1866, 1869, 1870, 1871, 1873, 1874, 1876, 1877, 1878; Reprint also listed in the Harvard University Library Online Catalog: 1875; Reprint also listed in WorldCat (OCLC First Search): 1868].
1858. How Plants Grow, A Simple Introduction to Structural Botany. With a Popular Flora, or an Arrangement and Description of Common Plants, Both Wild and Cultivated. Botany for Young People and Common Schools. Illustrated by 500 wood engravings. Ivison, Blakeman, Taylor, & Co., New York. 233 pp. [Also published in 1858 by American Book Company, New York, with 233 pp.]. [Reprints listed in *The National Union Catalog* (1972):1859, 1860, 1861, 1862, 1863, 1864, 1865, 1866, 1867, 1868, 1869, 1870, 1871, 1872, 1873, 1874, 1875, 1876, 1877, 1878, 1879; Reprints also listed in the Harvard University Library Online Catalog:1880, 1889; Reprints also listed in WorldCat (OCLC First Search):1881, 1900].
1872. How Plants Behave: How They Move, Climb, Employ Insects To Work for Them, &c. Botany for Young People. Part II. Ivison, Blakeman, Taylor, and Company, New York and Chicago. viii, [9]–46 pp. [Also published in 1872 by American Book Company, New York, with 46 pp.]. [Reprints listed in *The National Union Catalog* (1972):1873, 1874, 1875, 1900].
1879. Gray's Botanical Text-book. 6th ed. Vol[ume] I. Structural Botany, or Organography on the Basis of Morphology; to Which Is Added the Principles of Taxonomy and Phytography, and a Glossary of Botanical Terms. Ivison, Blakeman, Taylor & Company, New York and Chicago. xii, 442 pp. [Reprints listed in *The National Union Catalog* (1972):1880, 1881, 1885, 1890, 1907].
1887. The Elements of Botany for Beginners and for Schools. Gray's Lessons in Botany. Revised ed. American Book Company, New York, Cincinnati, Chicago. viii, 9–226 pp. [Reprints listed in *The National Union Catalog* (1972):1889, 1890, 1901].

## APPENDIX II

GRAY'S SCHOOL AND FIELD BOOK OF BOTANY (1868),  
TWO BOOKS IN ONE

*Gray's School and Field Book of Botany* (1868) consisted of two of Gray's books bound together in one, the *Lessons in Botany* (1857) and the *Field, Forest, and Garden Botany* (1868). First issued in 1868, the two together formed a popular and comprehensive botanical work that could be used by beginning and advanced classes (Fig. 6). In reality, this book was Gray's answer to Alphonso Wood's earlier challenge for a textbook that presented the terminology of botany along with a manual for field identification. Wood's *Class-book* (1845), issued over 20 years previous to 1868, and still being reprinted, was still available for class use. Now, however, it was time for a book having a fresh approach that combined botanical lessons with floristic and identification information. According to the publisher's preface: [Gray's book was]

... adapted to beginners and advanced classes, to Agriculture Colleges and Schools, as well as to all other grades in which the science is taught; ... also adapted ... as a hand-book to assist in analyzing plants and flowers in field study of botany, either by [students in] classes or individuals.

It is a *Grammar* and *Dictionary* of Botany, and supplies a great desideratum to the Botanist and Botanical Teacher, there being no similar class-book published in this country.

## REFERENCE

1868. Gray's School and Field Book of Botany. Consisting of "Lessons in Botany [1857]," and "Field, Forest, and Garden Botany [1868]," bound in one volume. Ivison, Blakeman, Taylor & Co., New York and Chicago. Lessons, xii, 236 pp.; Field, 7–386 pp. [Reprints listed in *The National Union Catalog* (1972):1869, 1870, 1871, 1872, 1873, 1874, 1875, 1876, 1877, 1878, 1879, 1880, 1881, 1887, 1890, 1895, 190?]. [Reprints from 1887 and the following years, consist of Gray's *Elements of Botany* ({1887}), rather than the



GRAY'S  
SCHOOL AND FIELD BOOK  
OF  
BOTANY.

CONSISTING OF

"LESSONS IN BOTANY," AND "FIELD, FOREST, AND  
GARDEN BOTANY,"

BOUND IN ONE VOLUME.

BY ASA GRAY,  
FISHER PROFESSOR OF NATURAL HISTORY IN HARVARD UNIVERSITY.

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WILEY, BLAKEMAN, TAYLOR & CO.,  
NEW YORK AND CHICAGO.

FIG. 6. Title page of *Gray's School and Field Book of Botany* (1868).



previous *Lessons in Botany* (1857). The title page, however, for the entire book referring to the two combined books in printings after 1887 continued to carry the subtitles, *Lessons in Botany and Field, Forest, and Garden Botany*].

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